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Engineers Without Borders El Salvador Project

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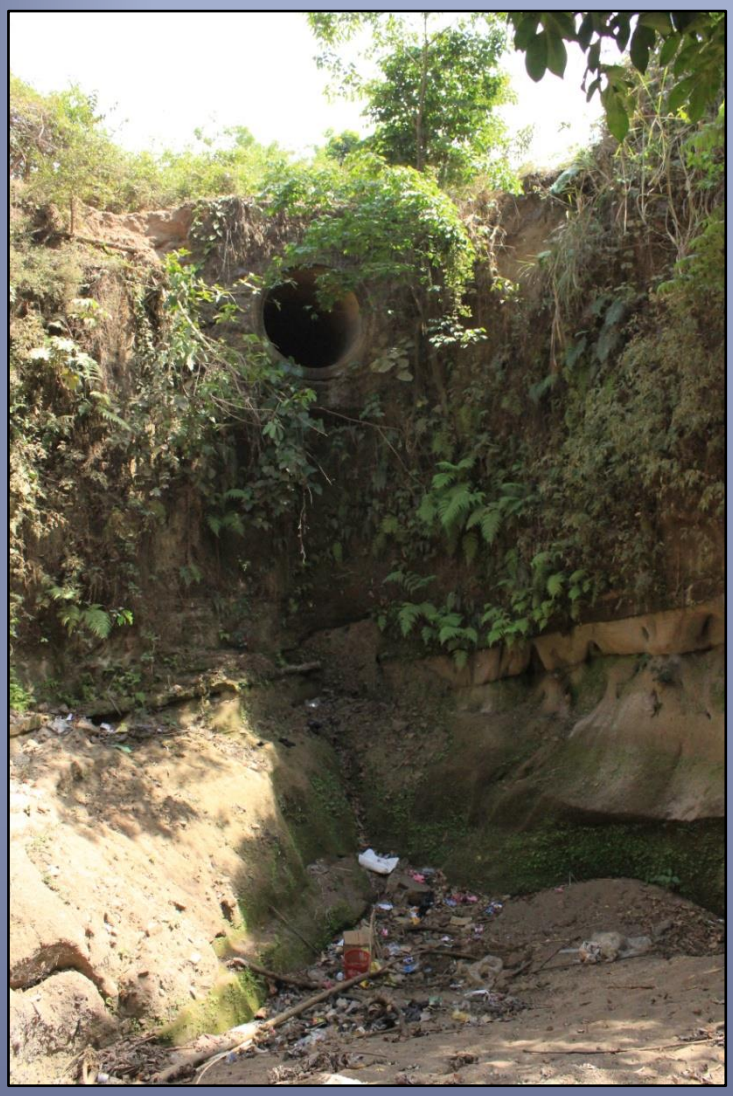

EWB El Salvador Project

Introduction

Engineers Without Borders (EWB) is a national organization that pairs the technology that is available in the United States with engineering projects in third world countries. EWB has two kinds of chapters. There are professional chapters which are made up of practicing engineers, and there are student chapters which draw their membership from college students and faculty members acting as advisors. Each chapter chooses a project in a foreign country and works with local residents to develop a feasible solution to their problems. These solutions are constrained by the technology that is available in the country. After a project is completed, the EWB chapter is required to monitor the design for at least four years.

Projects are first proposed by citizens in third world countries. These proposals are sent to EWB national where they are evaluated and the ones that are deemed adequate are posted on the EWB website with a description of the project. Chapters can then search for these projects and decide which ones are best suited for their particular skill set.

The EWB chapter at Montana Tech was founded the fall of 2008. Early on the chapter began fundraising and sent a student Khwisero, Kenya with the MSU EWB chapter which has an established project in Kenya. The EWB MT Tech chapter grew enough that by the spring of 2010 the chapter was able to adopt its own project. This project is located in San Juan El Espino, El Salvador. For this project EWB MT Tech is working to mitigate an erosion problem that is making it difficult for children to travel to school.

Project Description

The project that EWB MT Tech chose is located in El Espino, El Salvador in Central America. It is roughly 100 km west of San Salvador which is the capital of El Salvador. The community that EWB MT Tech is helping has an erosion problem. A road that links the rural community in the area to the local town is being slowly eroded by a stream. The water flows under the road through an existing culvert and then falls from the road level into a hole that is 30 feet below the road. Figure 1 shows the existing culvert and the hole that the water is currently falling into

Figure 1 Guacamayero

The area is called the gucacamayero by the locals which means big hole in Spanish. Figure 1 was taken during the dry season. During the rainy season the river can reach a peak flow rate of 750 cfs. This large change in flow rate is due to the seasonal rain fall. On average El Salvador receives 4 feet of rain every year. Over 90% of this rain comes during the rainy season which is May through October.

The road has been slowly moving up stream. As the face of the drop erodes, the road is pushed back from the edge of the hole. The farmer who owns the land upstream of the culvert has been selling the land and allowing the road to be rebuilt as needed, but he has recently decided that he will not sell any more land. As of right now, the road has a severe kink in it caused by the movement of the road over the stream. This kink makes it difficult for larger vehicles to drive through the area.

Originally, the residents thought that a bridge should be constructed over the river to avoid the erosion problem. After the first assessment trip and looking more thoroughly at the situation, it was determined that the long-term solution was to fix the erosion problem.

Design Development

Several different options were analyzed to determine which one presented the best solution to the problem. There were two major designs that were evaluated. The first design called for the hole to be filled and the water to be brought down to the level of the downstream river on a slope ranging from 2:1 to 3:1. The second design calls for a drop pool. The water is dropped into the same hole from the same elevation but the bottom of the pool is protected from the water with rock or concrete.

Slope Design

The idea of filling in the hole and then creating a gentler slope for the water to run down had two main variations. Both variations had the hole filled in and the water running down the slope that was created. The first design called for Gabion mattresses to be installed on the slope where the water was expected to be. A picture of Gabion mattresses is shown in Figure 2.

Gabion Mattresses from Modular Gabion Systems

The Gabion mattresses are constructed from a wire mesh that forms the frame for the mattress. The wire mesh is then filled with rocks and installed as needed. The wire mesh holds the rocks in place and allows the rocks to be stacked easier than if they were merely piled up. The Gabion mattresses would help to dissipate the energy of the water and there would be rip rap placed along the channel at the bottom of the Gabion mattresses to protect the main channel.

The second variation of the slope design was to run the water through a covered pipe. The covered pipe would reduce the chance that debris could fall onto the slope and clog the water

way. This option would require an energy dissipater of some kind to be installed at the bottom of the pipe and the channel to be riprapped for some distance after the end of the pipe.

Both of the slope creation designs require a significant amount of fill material to be found, hauled to the site, spread, and compacted. Finding the correct kind of fill could be a problem. If the soil grain size and type are not matched with the current soil, a slippage plane would develop between the fill and the existing soil. This could create major stability problems for the slope. This design was also very labor intensive. It is uncertain if large machinery is available in El Salvador so it had to be assumed that he majority of the fill distribution would be done by hand.

Drop Pool

The second design that was considered was called the drop pool. For this design, a wall of Gabion baskets would be erected on the face of the drop pool. Figure 2 shows the general arrangement of the Gabions.

Figure 2 Gabion Basket Wall from Maccaferri Environment Solutions

The Gabions in Figure 2 are slanted into the hill slightly and are not placed directly on top of each other. By placing the Gabions at a slight angle into the hill, the stability of the wall is increased. Offsetting the Gabions also creates a more structurally sound wall. The Gabions are expected to be 1 meter by 2 meters by 1 meter. The existing hole will be layered with Gabion baskets to dissipate the energy developed by the water falling from the culvert. There will also be Gabion baskets on the sides of the pool to reduce the likelihood of future erosion. At the end of the drop pool, there will be a line of Gabion baskets that stick up above the floor of drop pool. This is designed to push the water upwards as the water leaves the drop pool to reduce the

chance of scouring occurring at the edge of the Gabion baskets. Figure 3 provides a cross section of the proposed plan.

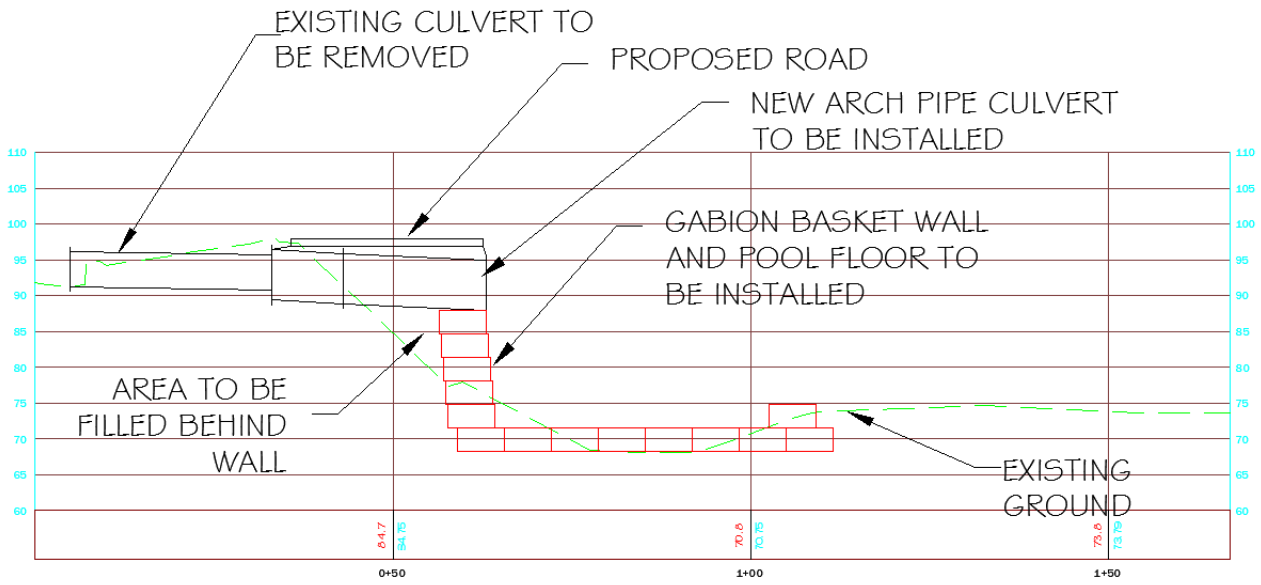

Figure 3 Proposed Design

This is the preliminary design which is subject to change when new data is received. There will be a team that is traveling to El Salvador at the end of the 2013 summer to finalize the design and provide additional information.

Road Realignment

The road will be realigned during construction. The plan is to move the road downstream, closer to where it was originally and fill in some of the erosion that has been caused. This will allow traffic to move through the area without having to slow down as much. The road will also be widened to further improve access to the area.

The culvert will also be improved to handle the expected flow. The residents say that during the rainy season water flows over the road because the culvert is too small. An arch pipe is being specified to go under the road. The arch pipe is designed for a peak flow of 750 cfs. The upstream slopes on both sides of the culvert will be armored with riprap to help guide the water into the arch pipe without causing excessive erosion.

Looking Forward

The project is far from over. The design phase is nearly complete. There have been two assessment trips sent down to El Salvador to gather information about the local area and the available supplies. There is another trip planned for the end of the 2013 summer. Construction is planned to start over Christmas break of the 2013-2014 school year. The funding for the project is slowly coming together as well. EWB MT Tech has committed to raise half of the funds for the project. It is estimated that between the project costs and getting people down to El Salvador to help with the construction administration that EWB MT Tech will need to raise over $30,000. Right now EWB MT Tech has less than half of that amount in hand. The most pressing matter now is to raise the money so that the design can be implemented and the people in El Espino El Salvador can use their road once again to travel to town and to school.